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Electromyographic Reflex Responses to Mechanical Force, Manually Assisted Spinal Manipulative Therapy

Christopher J. Colloca, DC,* and Tony S. Keller, PhD†

Study Design. Surface electromyographic reflex responses associated with mechanical force, manually assisted (MFMA) spinal manipulative therapy were analyzed in this prospective clinical investigation of 20 consecutive patients with low back pain.

Objectives. To characterize and determine the magnitude of electromyographic reflex responses in human paraspinal muscles during high loading rate mechanical force, manually assisted spinal manipulative therapy of the thoracolumbar spine and sacroiliac joints.

Summary of Background Data. Spinal manipulative therapy has been investigated for its effectiveness in the treatment of patients with low back pain, but its physiologic mechanisms are not well understood. Noteworthy is the fact that spinal manipulative therapy has been demonstrated to produce consistent reflex responses in the back musculature; however, no study has examined the extent of reflex responses in patients with low back pain.

Methods. Twenty patients (10 male and 10 female, mean age 43.0 years) underwent standard physical examination on presentation to an outpatient chiropractic clinic. After repeated isometric trunk extension strength tests, short duration (<5 msec), localized posteroanterior manipulative thrusts were delivered to the sacroiliac joints, and L5, L4, L2, T12, and T8 spinous processes and transverse processes. Surface, linear-enveloped electromyographic (sEMG) recordings were obtained from electrodes located bilaterally over the L5 and L3 erector spinae musculature. Force–time and sEMG time histories were recorded simultaneously to quantify the association between spinal manipulative therapy mechanical and electromyographic response. A total of 1600 sEMG recordings were analyzed from 20 spinal manipulative therapy treatments, and comparisons were made between segmental level, segmental contact point (spinous *vs.* transverse processes), and magnitude of the reflex response (peak–peak [p-p] ratio and relative mean sEMG). Positive sEMG responses were defined as >2.5 p-p baseline sEMG output (>3.5% relative mean sEMG output). SEMG threshold was further assessed for correlation of patient self-reported pain and disability.

Results. Consistent, but relatively localized, reflex responses occurred in response to the localized, brief duration MFMA thrusts delivered to the thoracolumbar spine and SI joints. The time to peak tension (sEMG magnitude) ranged from 50 to 200 msec, and the reflex response times ranged from 2 to 4 msec, the latter consistent with intraspinal conduction times. Overall, the 20 treatments produced systematic and significantly different L5 and L3 sEMG responses, particularly for thrusts delivered to the lumbosacral spine. Thrusts applied over the transverse processes produced more positive sEMG responses (25.4%) in comparison with thrusts applied over the spinous processes (20.6%). Left side thrusts and right side thrusts over the transverse processes elicited positive contralateral L5 and L3 sEMG responses. When the data were examined across both treatment level and electrode site (L5 or L3, L or R), 95% of patients showed positive sEMG response to MFMA thrusts. Patients with frequent to constant low back pain symptoms tended to have a more marked sEMG response in comparison with patients with occasional to intermittent low back pain.

Conclusions. This is the first study demonstrating neuromuscular reflex responses associated with MFMA spinal manipulative therapy in patients with low back pain. Noteworthy was the finding that such mechanical stimulation of both the paraspinal musculature (transverse processes) and spinous processes produced consistent, generally localized sEMG responses. Identification of neuromuscular characteristics, together with a comprehensive assessment of patient clinical status, may provide for clarification of the significance of spinal manipulative therapy in eliciting putative conservative therapeutic benefits in patients with pain of musculoskeletal origin. [Key words: biomechanics, electromyography, low back pain, manipulation-chiropractic, reflex responses, spine-thoracic/lumbar] **Spine 2001;26:1117–1124**

Spinal manipulative therapy (SMT) is a commonly used conservative treatment shown effective in studies of low back pain (LBP) treatment.[1,19,31,32] Although beneficial effects of SMT have been observed, considerable controversy exists regarding the precise nature of its therapeutic effects. Anecdotal evidence suggests that neuromuscular reflex responses may have a role in positive benefits derived from SMT, but little work has been done to date investigating physiologic responses.[11]

Neurophysiologic research has identified mechanosensitive and nociceptive afferents in the lumbar intervertebral discs,[3,6,25,28] zygapophysial joints,[7,20,23,45] spinal ligaments,[5,14,15,44] and paraspinal musculature[2,46] in both animal and human studies. When stimulated, these afferents contribute to an active reflex system acting to stabilize the spine.[34] Because stimulation or modulation of the somatosensory system has been put forth as a possible mechanism to explain the effects of SMT,[8,13,27,43] neuromuscular reflexes are of interest to researchers and clinicians. Beneficial effects of SMT have been thought to be associated with mechanosensitive af-

From the *Postdoctoral & Related Professional Education Department, Logan College of Chiropractic, St. Louis, Missouri, Private Practice of Chiropractic and the National Institute of Chiropractic Research, Phoenix, Arizona; and the †Department of Mechanical Engineering and the Department of Orthopaedics and Rehabilitation, University of Vermont, Burlington, Vermont.
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Table 1. Patient Demographics

Parameter	All Patients (n = 20)	Males (n = 10)	Females (n = 10)
Age (yr)	43.0 (18.4)	52.2 (16.0)	33.7 (16.3)
Weight (kg)	72.9 (14.4)	83.0 (10.3)	62.9 (10.2)
Height (cm)	173.0 (10.3)	179.2 (7.4)	166.6 (9.1)

Values are mean (SD).

ferent stimulation and presynaptic inhibition of nociceptive afferent transmission in the modulation of pain,[41,42] inhibition of hypertonic muscles,[11,13,39] and improved functional ability.[24,30,40]

Characterization of reflex responses associated with different forms of SMT establishes a framework for research to investigate manipulation theories. Yet, a systematic evaluation of reflex responses associated with SMT has not been performed in patients with LBP. Therefore, the purpose of this prospective clinical study was to investigate electromyographic reflex responses in symptomatic subjects treated for LBP. Force–time histories were obtained so that the temporal association between SMT force application and electromyographic response could be precisely determined. Comparisons of results were made with self-reported measures of pain and disability.

■ Methods

Subjects. Twenty patients with LBP (10 male and 10 female, age 43.0 ± 17.5 years [mean ± SD, range 15–73 years) were included in the study if they had not consulted a physician for LBP or leg pain in the past 6 months, or previously underwent SMT (Table 1). Patients were excluded if they were pregnant, had previous history of lumbar surgery, or presented any contraindication to SMT. After written and verbal explanation of the protocol, patients signed a written informed consent form acknowledging their participation.

Procedure. Patients completed history outcome assessment questionnaires (visual analog score [VAS], SF-36, and Oswestry Low Back Disability Index) and underwent a physical and radiographic examination performed by a licensed chiropractic physician in accordance with standard clinical practice. Based on these findings, patient symptomatology and physical status were used for inclusion criteria in the study.

Each subject was placed in the prone position by use of a motorized vertical/horizontal table (Softec/Tri-W-G, Valley City, ND). Following skin preparation, pregelled, self-adhesive 1-cm silver/silver chloride bipolar electrodes (Easytrode 3SG3-N, MultiBioSensors, El Paso, TX) were attached 2.5 cm apart bilaterally over the erector spinae at its aponeurotic origin overlying the multifidus at L5 and overlying the iliocostalis lumborum at L3. The electrodes were positioned such that thrusts could be delivered to both the spinous processes (SPs) and transverse processes (TPs) without contact with the electrodes or leads.

To normalize the surface, linear-enveloped electromyographic (sEMG) reflex data, active contraction of the trunk muscles was performed. After a brief testing session, patients were asked to perform three consecutive prone isometric trunk extensions, lifting their chest and shoulders off the table maximally for 3 seconds while sEMG data were collected at 50 Hz over a 30-second time interval. A 5-second rest was given between exertions. No trunk force measurement devices or trunk confinement apparatus were employed. Linear-enveloped sEMG (Noraxon Myotrace 10, Finland) and thrust force (PCB model 201A03, Depew, NY) signals were recorded using a Biopac MP100 (Biopac Systems, Inc., Santa Barbara, CA) 16-bit data acquisition system directly into the computer using Acknowledge software (Biopac Systems, Inc.). A linear envelope detector circuit consisting of a zero offset full-wave rectifier and bandpass filter (16–500 Hz), followed by a low-pass filter (10 msec time constant) was used to electronically process the raw EMG signal. Hereafter, the linear enveloped surface electromyographic signal will be referred to as sEMG.

Figure 1. The experimental setup for a spinal manipulative thrust applied over the L4 spinous process. The hand-held spinal manipulation device, the Activator Adjusting Instrument, equipped with an impedance head and preload control frame, is shown with its 1 cm 80-durometer rubber tip attached to the end contacting the patient. The device is manually activated by means of a spring mechanism that propels a hammer into a stylus producing an approximate 150 N force in about 5 msec. Electrode placement adjacent to the L3 and L5 functional spinal units is shown.

Spinal Manipulative Therapy. An Activator Adjusting Instrument (AAI, Activator Methods, Inc., Phoenix, AZ) equipped with a preload control frame and impedance head (load cell and accelerometer) was then used to systematically deliver highly vocalized mechanical force, manually assisted (MFMA) posteroanterior thrusts to several common spinal landmarks (Figure 1). The AAI is a hand-held, manually activated and adjustable force, chiropractic manipulation instrument that produces a loading history approximately 5 msec and 150 N in peak amplitude.[18] A total of 20 thrusts were made on common treatment sites, including the left and right posterior superior iliac spine, left and right sacral base 2 cm lateral to the first sacral tubercle, S1, and L5, L4, L2, T12, T8 transverse (left and right), and SPs.

The thrusts were consistent with SMT used in routine chiropractic practice, directed perpendicular to the body surface curvature with a 25 N preload. Neuromuscular sEMG reflex activity of the erector spinae muscles and thrust force were recorded simultaneously during each thrust. An external trigger was used to initiate data collection, and the linear-enveloped sEMG and thrust force were sampled at 10 kHz over

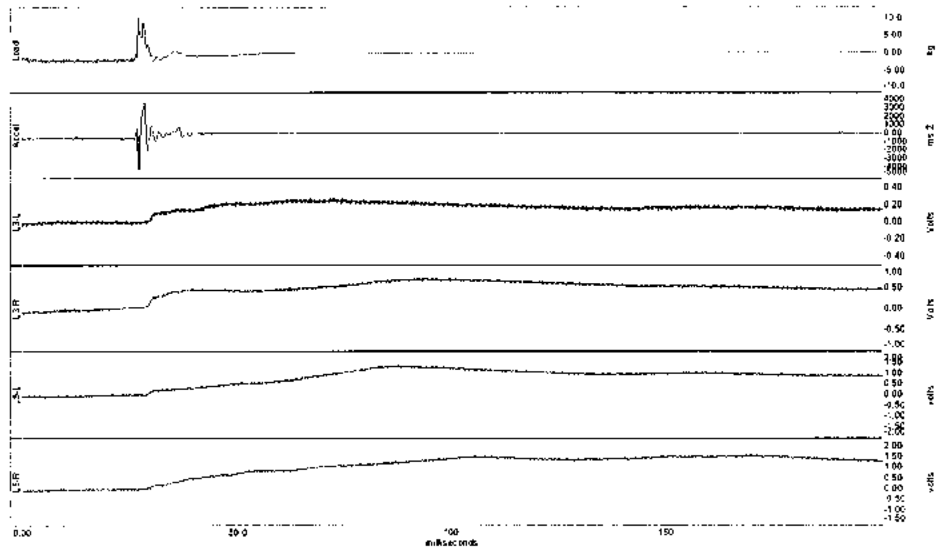

Figure 2. Typical load time, acceleration time, and linear-enveloped sEMG time responses for thrust applied to the L4 spinous process (patient 17). In this example the approximately 10-kg peak force ($\pm$ 4000 msec^{-2} peak acceleration) MFMA thrust produced a positive sEMG response (p-p ratio threshold $>$ 1.5) in all four sEMG leads.

a 273-msec time interval. The 20 MFMA thrusts and four sEMG measurement sites resulted in a total of 80 sEMG measurements per subject.

Data and Statistical Analyses. Baseline and peak sEMG values were obtained from each of the three trunk extension tasks, and baseline-to-peak values were averaged to obtain the isometric trunk extension task mean value (*Ext*). Baseline and peak sEMG values were also determined from neuromuscular reflex responses to the MFMA thrusts as follows. First, a peak detector was used to find the force peak in the force–time history. A 10-msec window immediately before the force peak and a 100-msec window immediately following were then analyzed to obtain baseline sEMG minimum, maximum, peak–peak (p-p), and mean values for each thrust. p-p reflex responses to thrusts were then categorized according to eight different baseline thresholds: >1.5×, >2.0×, >2.5×, >3.0×, >3.5×, >4.0×, >4.5×, and >5.0× the baseline p-p sEMG values. A 1.5-fold increase (1.5×) represents a very weak reflex response, whereas a fivefold increase (5.0×) represents a very strong reflex response. Reflex response to the MFMA thrusts (relative mean sEMG) was also quantified in terms of the isometric trunk extension task mean value (*Ext*)[29]: relative mean sEMG = (*Task* − *Rest*)/(*Ext* − *Rest*), where *Task* and *Rest* correspond to the mean sEMG responses obtained during the 100-msec time window (post-thrust) and 10-msec time window (baseline), respectively.

The number of positive reflex responses across the 20 patients was determined for each of the 20 thrusts according to each of the p-p threshold criteria, and the number of responders was determined for thrusts on the SPs and TPs. Thrusts applied to the TPs were also assessed for contralateral reflex responses. A chi square (α = 0.05) analysis was performed to determine whether all 20 thrusts and subtreatments (thrusts on TPs, SPs, contralateral side) elicited the same response. A two-tailed *t* test was used to determine whether p-p sEMG responses were different for the data grouped according to VAS (score ≤5 or >5), Oswestry (disability index ≤10 or >10), LBP history (none–subacute or chronic), and LBP symptom frequency (none–intermittent or frequent–constant).

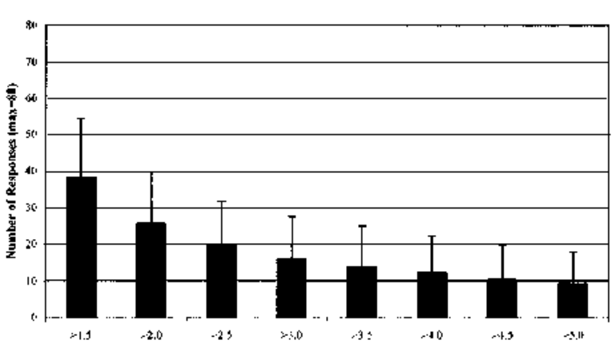

Figure 3. Mean sEMG responses obtained for the combined L3 and L5 electromyographic leads (left and right) in response to MFMA thrusts applied to the 20 segmental contact points. The number of sEMG responses decreased with increasing p-p ratio threshold (abscissa). For a given patient the maximum number of responses was 80 (20 thrusts × 4 electrodes). Error bars represent standard deviation.

Table 2. Percent of Patients Exhibiting sEMG responses for p-p Threshold Values Ranging From 1.5× Baseline to 5.0× Baseline in 0.5× Increments

p-p sEMG Threshold	L3–L	L3–R	L5–L	L5–R
>1.5×	100	100	95	100
>2.0×	80	100	85	90
>2.5×	65	80	75	70
>3.0×	55	55	70	65
>3.5×	50	35	70	65
>4.0×	50	35	60	65
>4.5×	40	35	60	60
>5.0×	30	35	60	55

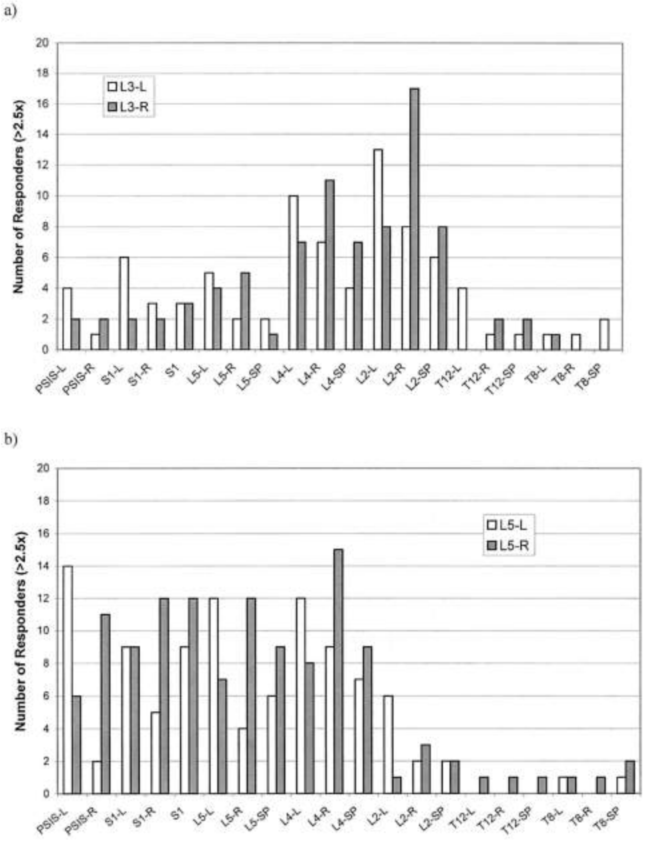

Figure 4. Number of positive sEMG responses (p-p ratio threshold > 2.5) obtained at each of the 20 MFMA segmental contact points for the L3 sEMG leads **(a)** and L5 sEMG leads **(b)**. Open and closed bars represent the number of left side and right side sEMG responses, respectively, of the 20 patients.

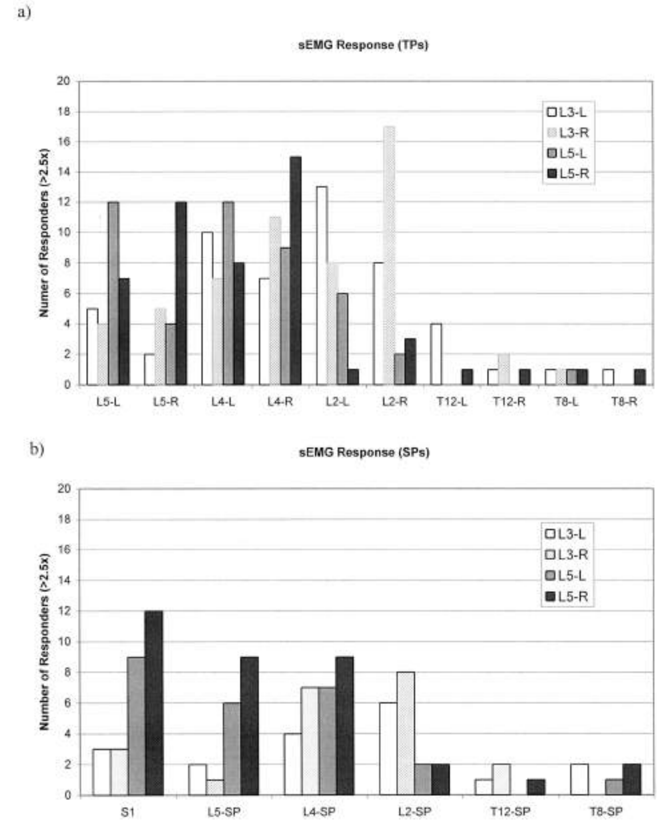

Figure 5. Number of positive L3 and L5 sEMG responses (p-p ratio threshold > 2.5) obtained at each of the 10 transverse process (TP) MFMA segmental contact points **(a)** and spinous process (SP) MFMA segmental contact points **(b)** of the 20 subjects.

■ Results

Demographic characteristics of the 20 patients are summarized in Table 1. Nine patients reported a VAS score ≥5, 10 reported that their LBP symptom frequency was frequent–constant, 11 indicated that they had a chronic history of LBP (>3 months), and 10 patients indicated that their functional disability was ≥20% (Oswestry >10).

The mean intrasubject variation in sEMG output was 11.6% for the three isometric trunk extension trials. There were no significant differences between the three trunk extension tasks (paired observations *t* test), nor were there any consistent changes in isometric trunk extension sEMG output patterns (increase, decrease, or neutral). MFMA thrusts elicited positive sEMG responses in all of the 20 patients examined. The majority of positive sEMG responses occurred within 4 msec (range 2.4–3.6 msec) of the thrust force peak and reached peak magnitude within 50–100 msec of the thrust force peak (Figure 2). The amplitude of the majority of the sEMG responses were less than 10% of the average isometric trunk extension value (relative mean = 1.4%, standard deviation = 1.6%), although some thrusts elicited reflex responses up to 50% of the isometric trunk extension value. Lower amplitude reflex responses (p-p ratio <2.5×, average relative mean <3.5%) tended to return to baseline values within the 273-msec recording time interval. However, the higher amplitude reflex responses lasted longer than the 273-msec recording time interval.

As expected, the p-p magnitude of the sEMG responses decreased with increasing p-p ratio threshold (Figure 3). When the data were examined across both patients and treatment locations, there was a 100% sEMG response in three of four electrodes for at least one treatment site at the 1.5× baseline threshold (Table 2). At 5.0× baseline threshold values, sEMG responses decreased to less than 60% when examined across both patients and treatment locations.

In a given subject, p-p ratio sEMG values showed a significant positive linear correlation ($R^2 > 0.9$) to the relative mean sEMG. A relative mean sEMG of approximately 3.5% of the isometric trunk extension sEMG response corresponded to a p-p ratio sEMG response of >2.5× the baseline threshold criteria. Hereafter, "positive" sEMG responses will be defined as sEMG signals that increased to at least 2.5× the p-p baseline. Table 3 summarizes the number of positive sEMG responses obtained as a function of thrust region and electrode site. Overall, a positive sEMG response was obtained in 392

Table 3. Summary of Positive sEMG Responses (Threshold = 2.5× Baseline) to MFMA Thrusts

Thrust Location	L3 Electrode Left	L3 Electrode Right	L3 Electrode L + R	L5 Electrode Left	L5 Electrode Right	L5 Electrode L + R	Combined
All levels	84	84	168	101	123	224	392
(20 thrusts)	(21.0)	(21.0)	(21.0)	(25.3)	(30.8)	(28.0)	(24.5)
Thoracic	10	5	15	2	7	9	24
(6 thrusts)	(12.5)	(6.3)	(9.4)	(2.5)	(8.8)	(5.6)	(7.5)
Lumbar	57	68	125	60	66	126	251
(9 thrusts)	(31.7)	(37.8)	(34.7)	(33.3)	(36.7)	(35.0)	(34.9)
Sacroiliac	17	11	28	39	50	89	117
(5 thrusts)	(17.0)	(11.0)	(14.0)	(39.0)	(50.0)	(44.5)	(29.3)
SPs	18	21	39	25	35	60	99
(6 thrusts)	(15.0)	(17.5)	(16.3)	(20.8)	(29.2)	(25.0)	(20.6)
TPs	52	55	107	46	50	96	203
(10 thrusts)	(26.0)	(27.5)	(26.8)	(23.0)	(25.0)	(24.0)	(25.4)

Total number of responses are shown for each electrode lead, left + right (L + R) L3 leads, L5 leads, and combined (L3 + L5) leads. Values in parentheses are percentage of electrode responses to all thrusts applied to a given region or contact point. In the case of thrusts at "All levels" there were a total of 20 thrusts × 20 patients per electrode. SPs = spinous processes; TPs = transverse processes.

(24.5%) of the 1600 total thrusts administered. The sEMG response was found to be dependent on thrust location. Treatments (overall, lumbar, thoracic, and SI) also produced systematic and significantly different sEMG responses ($\alpha = 0.05$). However, there were no significant differences in left side *versus* right side sEMG responses (L3 or L5 electrode) in response to thrusts applied to the SPs.

The greatest sEMG response occurred for localized thrusts delivered adjacent to the L5 and L3 electrodes, and decreased in magnitude as the thrusts were delivered farther from the electrode sites. Figure 4 summarizes the left side and right side L3 and L5 sEMG responses for each of the 20 treatment sites. The strongest positive L3 sEMG response was seen for thrusts applied over the L2 and L4 processes (Figure 4a), whereas more caudal segmental contact produced the strongest positive electromyographic response in the L5 electrodes (Figure 4b). Overall, thrusts applied over the TPs produced more positive sEMG responses (25.4% responders) than over the SPs (20.6%) (Figure 5 and Table 3). Left side and right side thrusts over the TPs elicited positive contralateral L3 and L5 sEMG responses where across patients there was up to a 35% (7 of 20 responders) positive sEMG contralateral response. When the data were examined across both patients and electrode site (L3 or L5, L or R), there was a 95% (19 of 20 patients) positive sEMG response.

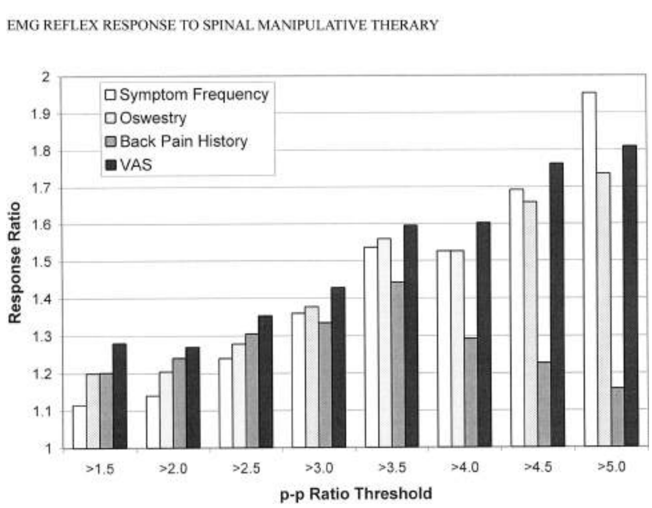

Figure 6. Changes in the response rate (ratio of mean number of sEMG responses) within each clinical category as a function of p-p ratio threshold. Response ratios for four clinical categories are shown: patient functional disability status (Oswestry > 10/ Oswestry ≤ 10), symptomatology (VAS > 5/VAS ≤), LBP history (chronic/none subacute), and LBP symptom frequency (frequent-constant/occasional-intermittent). All four clinical categories were associated with an increasing response ratio with increasing p-p ratio, although there was a decrease in the LBP history response rate above a p-p ratio threshold of 3.5.

There were no significant differences in subject sEMG responses grouped according to VAS, Oswestry, LBP history, or LBP symptom frequency. However, the relative response ratio of the mean sEMG responses for patients classified according to the above clinical outcomes was closely dependent on the sEMG p-p ratio threshold (Figure 6). Response ratios for patients classified on the basis of Oswestry disability index, VAS score, and LBP symptom frequency tended to increase with increasing sEMG p-p ratio threshold. In particular, the sEMG response ratio for LBP symptom frequency increased from a nearly 1:1 ratio to a nearly 2:1 ratio as the p-p ratio threshold increased from >1.5 to >5.0. Differences in sEMG responses for patients with frequent–constant LBP in comparison with patients with occasional–intermittent LBP approached significance ($P = 0.12$) at the highest p-p ratio threshold examined. In the case of patients classified according to LBP history there was a decrease in the sEMG response ratio above a p-p ratio threshold of 3.5.

■ Discussion

The current study represents the first systematic investigation of sEMG reflex responses in patients treated for

LBP using SMT. We found consistent neuromuscular reflex responses to MFMA manipulative thrusts applied to the thoracolumbar spine and sacroiliac joints. Neuromuscular reflex responses were observed for thrusts delivered over bony landmarks (SPs) as well as for segmental contact points overlying erector spinae muscle (TPs). Thrusts delivered to the TPs also elicited contralateral reflex responses. The amplitude and frequency of the reflex responses were found to vary appreciably among patients and corresponded closely with self-reported measures of pain and disability. Thus, patients with more severe LBP characteristics tended to have more hyperneuromuscular responses. However, no significant differences were found for patients grouped according to pain and disability, most likely reflecting the relatively small number of patients examined.

Our results support the findings of previous work by Herzog et al[13] who found consistent neuromuscular responses to manual SMT in 10 asymptomatic young men. They reported that the reflex responses occurred within 50–100 msec after the onset of the thrust, lasting 100–400 msec. Symons et al[38] conducted an experiment using MFMA SMT and observed that approximately 68% of the thrusts resulted in a detectable reflex response (3× baseline), which is consistent with our findings. Both of these studies, however, limited their analysis to a relatively small sample of asymptomatic young subjects and did not quantify the force–time histories of the reflex responses compared with the application of the SMT.

We found that neuromuscular reflex responses occurred within 2–4 msec of initiation of the thrust, which corresponds temporally with the thrust maximum force. The onset of reflex responses during MFMA thrusts is consistent with intraspinal conduction times and spinal reflex times for muscle stretch (2–7 msec).[4,9] Noteworthy are the findings that very short duration (<5 msec) MFMA thrusts produce neuromuscular reflex responses that are similar to manual SMT for which force–time histories are approximately 400 msec in duration.[13] These authors also noted that the onset of the reflex response during manual SMT corresponded temporally to the thrust maximum force, in this case approximately 100 msec after the initiation of the thrust. Our findings support the notion that the production of neuromuscular reflex response is thought to be dependent on the rate of change in force and deformation during the treatment rather than the force or stretch magnitude itself.[12,13]

We also observed that many MFMA SMT reflex responses, particularly higher amplitude reflex responses, lasted longer than the 273-msec data acquisition recording time interval. Because there was a general trend for higher amplitude reflex responses in those patients reporting more frequent to constant LBP, we hypothesize that this may reflect an underlying physiologic alteration of the back musculature. We cannot elaborate further on this important issue because the extremely short duration force–time history of the MFMA SMT thrust necessitated acquiring the force–time and sEMG–time history data at a very high acquisition rate (10 kHz), which limited our recording time to 273 msec. This was the maximum time interval that our data acquisition equipment could sample: 6 channels at 10 kHz. Longer duration sEMG recordings should be conducted to more fully characterize the reflex response of the paraspinal musculature.

Experimental muscle pain has been found to be associated with increased stretch reflex amplitude in other studies.[21,22,47] This finding, if confirmed in a larger group of patients, may in the future assist in objective documentation of LBP patients. While we postulate that the sEMG responses to MFMA SMT may arise from a wide variety of discoligamentous and muscular afferents, more work is needed to determine which spinal constituents mediate the electromyographic signals.

Neuromuscular reflex responses were also observed in response to thrusts delivered several segments cephalad and caudal to the electrode locations. This is consistent with the findings by previous investigators[13,36] and presumably reflects the multisegmental anatomic nature of the erector spinae,[16] for which sensory inputs are known to ascend or descend as much as three or four spinal levels *via* interneuronal connections with motor neurons.[3,10] Given that MFMA thrusts applied to the T12 SPs have been found to cause significant rotations of the L3–L4 and L4–L5 functional spinal units,[26] distal reflex responses are not surprising. Deformation of mechanosensitive afferents has been found to be associated with reflex responses in the adjacent musculature in other studies.[15,27,34,35] Such global responses may result from neural integrations of local reflex responses or from mechanical deformation of mechanosensitive afferents located distally from the segmental contact point.[9,33]

The 1-cm^2 contact surface of the instrument used in our study allowed us to impart highly localized thrusts adjacent to the sEMG leads. However, a limitation of the current study is the possibility that thrust-induced motion artifacts may have produced unwanted signals in the sEMG electrodes. Although we cannot absolutely assert that motion artifacts did not influence the sEMG signal, we found that thrusts over the SPs resulted in comparable sEMG signals in comparison to thrusts over the adjacent TPs. In addition, the signal conditioning equipment used eliminated low frequency muscle–skin and electrode motion artifact phenomena using an electronic feedback technique to cancel out low frequency changes in the acquired physiologic signal.

Additional work is required to elucidate the short- and long-term temporal relationships between mechanical characteristics of SMT thrusts (force amplitude and duration) and neuromuscular responses. Recently, Keller and Colloca[17] reported a statistically significant 21% increase in sEMG output in LBP subjects following MFMA SMT. This finding led the authors to hypothesize that neuromuscular reflex effects of spinal manipulation may improve the functional capacity of the targeted trunk muscles. This work and that of others investigating the physiologic responses in patients with musculoskeletal disorders[37] assist to clarify the role of spinal manipulative treatment in this patient population. Longer duration sEMG recordings should be conducted to more fully characterize the reflex response of the paraspinal musculature. Information obtained from such studies may ultimately maximize potential therapeutic benefits of SMT and serve to objectively evaluate LBP patients.

Conclusions

The current study demonstrated that MFMA SMT produced consistent, generally localized sEMG responses in LBP patients. The fact that reflex responses are stimulated by brief-duration dynamic mechanical thrusts suggests that neurophysiologic processes may be linked to putative SMT results. In this regard, identification of neuromuscular characteristics, together with a comprehensive assessment of patient functional, physical, and subjective health status, may provide for better understanding of the lumbar spinal disorders and for clarification of the mechanisms and significance of SMT.

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Key Points

- Consistent localized neuromuscular reflex responses occur in the adjacent trunk musculature during spinal manipulative therapy in patients with low back pain.
- The time to peak tension of the surface electromyographic magnitude ranged from 50 to 200 msec, and the reflex response times ranged from 2 to 4 msec.
- Patients with frequent to constant back pain tended to have higher electromyographic responses in comparison with patients with occasional to intermittent pain.

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Address reprint requests to

Christopher J. Colloca, DC
State of the Art Chiropractic Center, P.C.
11011 S. 48th Street, Suite 205
Phoenix, AZ 85044
E-mail: cjcolloca@neuromechanical.com